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Ergonomics Handbook

V. Venda

Basic Ergonomic Factors

Environment:
Noise & Lighting

The Back

The Hand

Work Design/
Organization

Anthropometrics

Posture

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Managers and employees, whether they are in a plant, a laboratory, an office or a warehouse, will find ideas in this handbook which apply to their work setting.

Ergonomics is important since it assists in achieving higher quality and greater effectiveness. In addition, ergonomic improvements to the work place have significantly enhanced employee job satisfaction and have reduced employee injuries.

You are encouraged to review this handbook and apply the principles of ergonomics as appropriate to your area of responsibility.

Remember, teamwork is an essential ingredient in achieving good work place ergonomics. Managers, engineers and employees can provide key information that can help to improve tasks.

This handbook has been designed to give readers a brief summary of the subject of ergonomics. Many of the recommendations cost very little to implement—others require considerable investment. Improvements based on this handbook should be cost-justified as with any other expenditure. Some of the recommendations may take several years to achieve.

For example, many of the chairs in use today could be improved upon with ergonomic designs. The notion of replacing all chairs not up to today's ergonomic standards would not be practical. The goal is a steady improvement. Ergonomics should not be seen as a one-time effort but as an approach that must be continually used in optimizing the working environment.

Why Ergonomics?

The application of ergonomic principles to work place design can result in increased effectiveness, work quality, health and safety, and job satisfaction. For these reasons, it is important that we focus our attention on and attempt to understand the interrelationships between people and machines.

What Is Ergonomics?

Ergonomics, the European word synonymous with human factors, was invented in the early 1950s by a group of scientists and engineers interested in the relationship between people and machine. The word is derived from the Greek "ergon"—work, and "nomos"—natural laws of.

In a business context, we perhaps associate machines most readily with factories. However, typewriters, telephones, dictating equipment, photocopiers and computer terminals, have established themselves so firmly that office employees have as much contact with machines as do factory employees.

There are two principles to ergonomics: fitting the person to the job and fitting the job to the person.

For a number of years there have been efforts to improve ergonomics—primarily in factories and product design. However, in spite of the extensive knowledge gained in these efforts, there are still many examples of products and work place design where ergonomic improvements can be made.

Think of two fairly recent innovations in our lives—the push button telephone and the pocket calculator. Both have a standard key set layout, but not the same layout.

Although either is satisfactory, the ergonomist sees this lack of uniformity in two such similar products as unfortunate, since the user has to learn two different layouts, and the learning from one can interfere with the other, causing inefficiency, increased error and frustration.

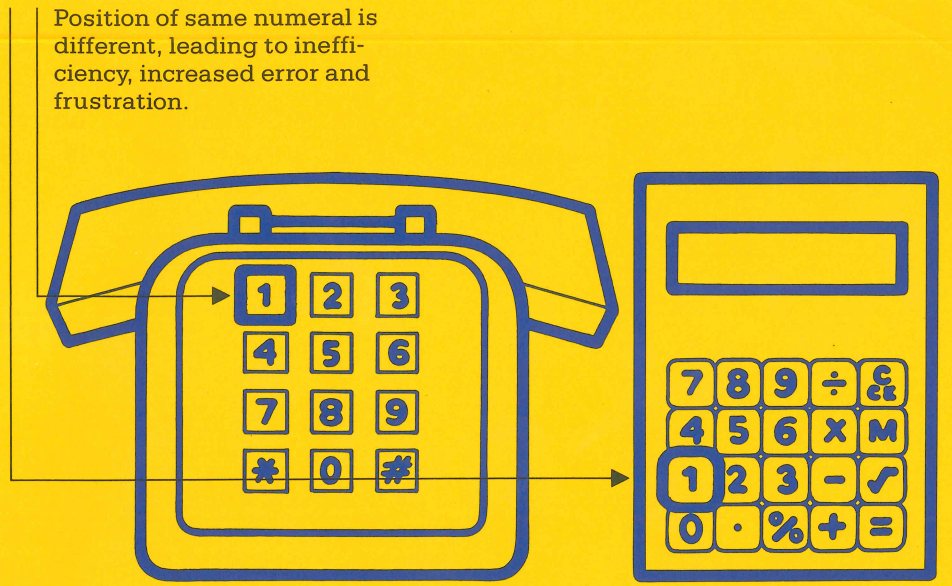
Another example of this is the layout of automobile controls. Consider the problems caused by some countries driving on the left and other countries driving on the right. Still another example is the design of the tipping mechanism of dump trucks. In one instance a major manufacturer had the brake lever in the same position that another manufacturer had the tip mechanism lever. Not surprisingly, an accident occurred when a man driving an unfamiliar brand of truck activated the tipping mechanism while checking the brake position. In doing so, he tipped the load and caused the truck to overturn.

We all have expectations as to the operation of the machines around us. Think of how you would rotate a knob to increase the volume on a radio or TV—it is always clockwise. This is standard throughout the world but the conventional toggle lighting switches in your home are on when the switch is in the up position in the U.S. and vice versa in Europe.

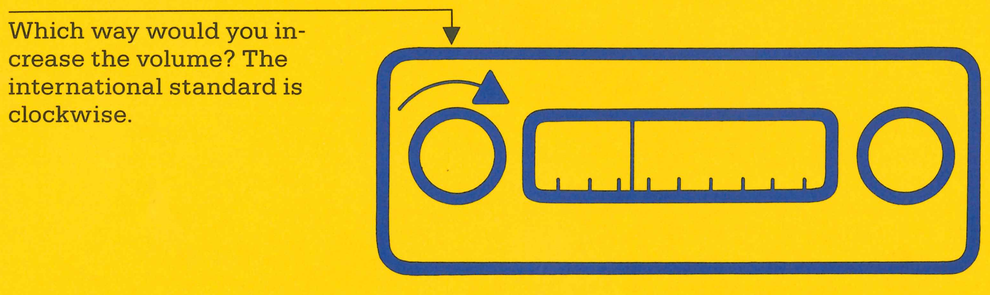
We have expectations about color. Red implies hot and on other occasions danger.

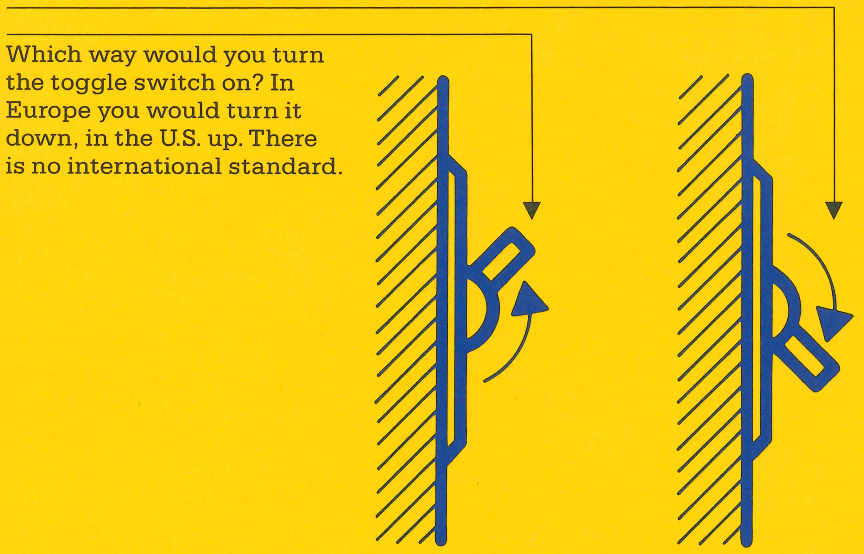
All of these expectations have to be considered when designing products or work environments. A properly designed work station can contribute to an employee's comfort, job satisfaction, motivation, and sense of well-being and accomplishment. Productivity and quality improvements will often result and will usually justify any extra costs of achieving improved design. Experience also shows a reduction in absenteeism and accidents.

Telephone/Calculator


Position of same numeral is different, leading to inefficiency, increased error and frustration.

Volume/Toggle Switches


Which way would you increase the volume? The international standard is clockwise.


Which way would you turn the toggle switch on? In Europe you would turn it down, in the U.S. up. There is no international standard.

Posture

Prolonged work in the same position, whether seated or standing, can cause discomfort. Where possible, movement should be incorporated into the task to prevent discomfort and fatigue.

Standing

Here are some guidelines for optimum posture for standing jobs:

Avoid having operators stand still in one place for unduly long periods of time. The activity of the leg muscles acts as a pump and assists the veins in returning blood to the heart. Prolonged standing stops this pumping action and this causes swelling of the lower extremities.

Provide a rubber or padded mat where prolonged standing cannot be avoided. This should reduce fatigue and improve comfort.

Sitting

The seated person who is uncomfortable may or may not be conscious of it. In either case, concentration spans are shorter, alertness is diminished and the person will consistently seek a more comfortable position.

A well-designed chair for the operator is one of the most important parts of a work station. It can favorably affect posture, circulation, the amount of effort required to maintain a position, and the amount of pressure on the spine.

The following recommendations should be followed:

▶ The seat should adapt to the user, not vice versa.

▶ Chairs should be stable and fully and easily adjustable from the seated position.

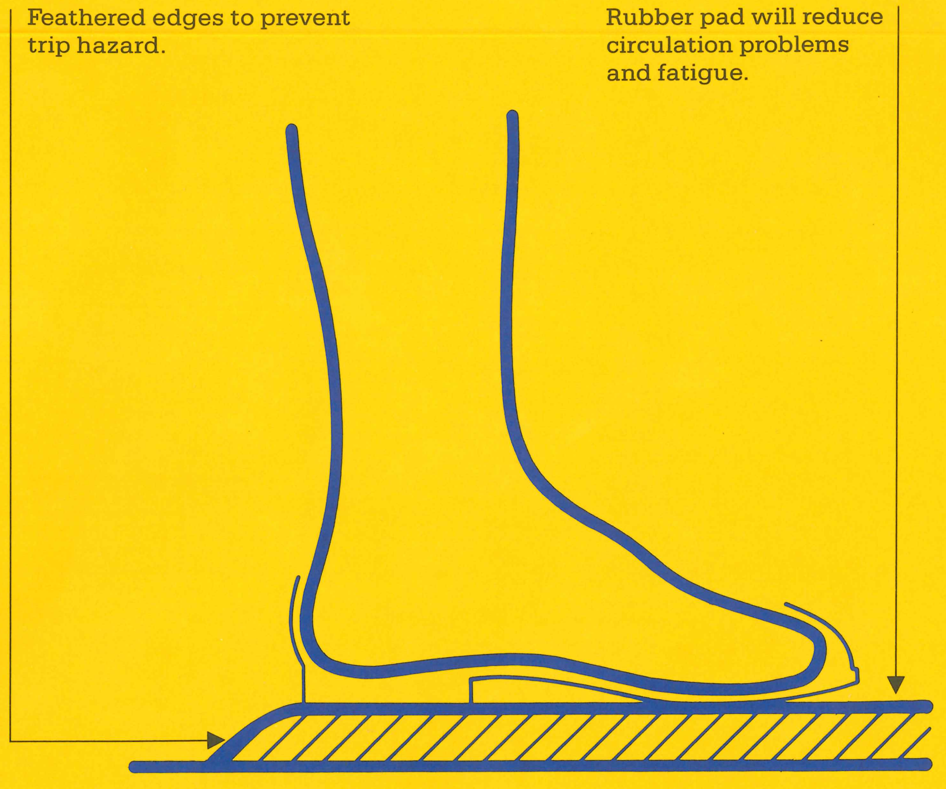
▶ Seat pans and backrests should be upholstered and covered in a material which absorbs perspiration. A 20 mm compression is about firm enough.

▶ Seat pan height should be adjustable and should transfer the user's weight through the buttocks, not the thighs.

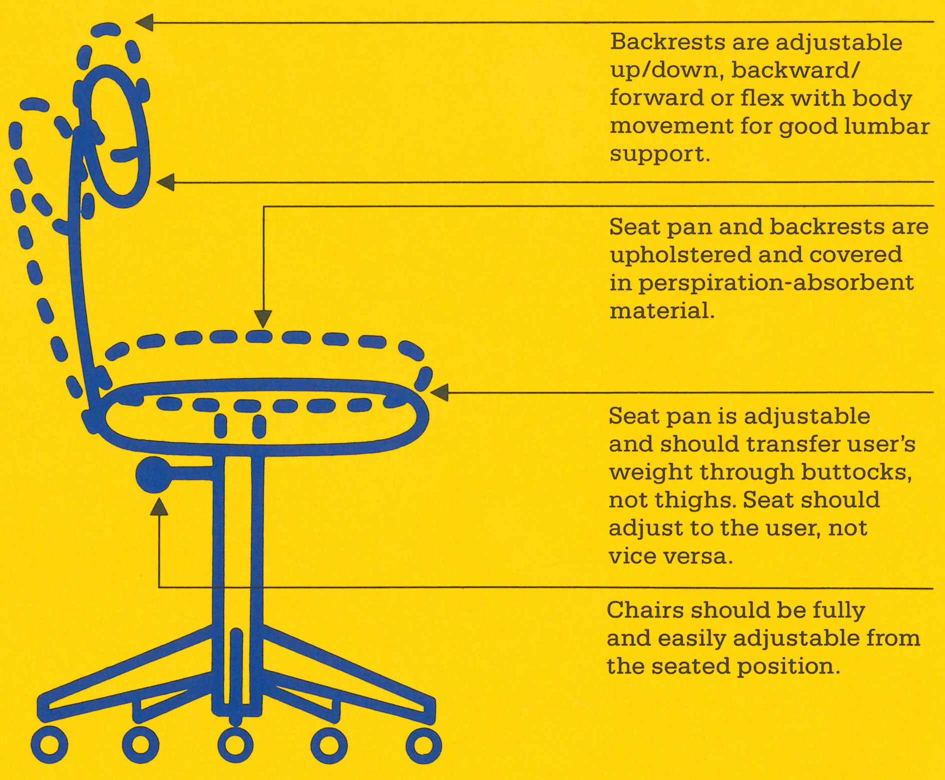
▶ Backrests should adjust up/down and backward/forward or flex with body movement for good lumbar support. A forward tilt of the seat pan may relieve body stress in certain applications since it allows the backrest to follow the person when performing varied tasks.

▶ Where mobility is required, wheels or casters should be fitted to the chair (hard casters for soft floors and soft casters for hard floors). Special consideration should be given in certain cases, for example, where a slippery floor makes it difficult to keep the chair in the desired position. Where wheels or casters are fitted, chairs should preferably have five legs. This offers improved stability and reduces the risk of tipping over.

Standing Posture


Feathered edges to prevent trip hazard.
Rubber pad will reduce circulation problems and fatigue.

Chairs


Backrests are adjustable up/down, backward/forward or flex with body movement for good lumbar support.
Seat pan and backrests are upholstered and covered in perspiration-absorbent material.
Seat pan is adjustable and should transfer user's weight through buttocks, not thighs. Seat should adjust to the user, not vice versa.
Chairs should be fully and easily adjustable from the seated position.

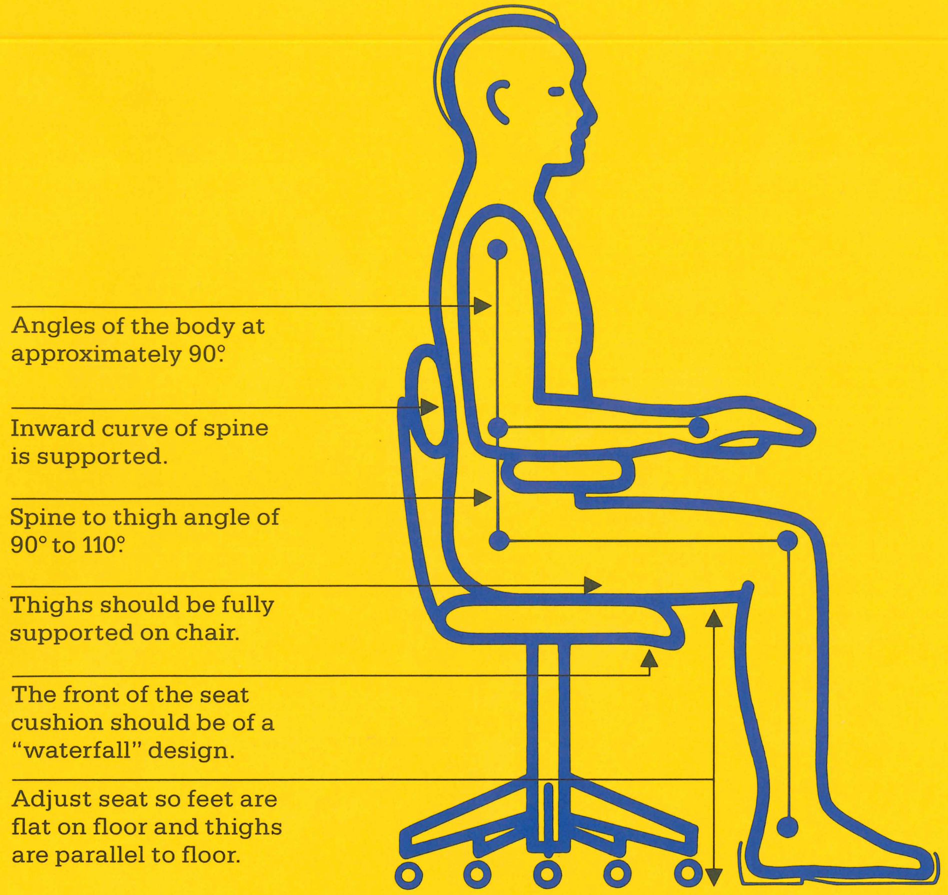
- ▶ The front of the seat should be of a "waterfall" design in order to provide sufficient clearance for the flesh of the thigh and to prevent reduction of blood circulation.

- ▶ For tasks requiring frequent lateral movements, seats should swivel.

- ▶ Holding the same seated position for long periods of time causes fatigue. The diagram on seat posture illustrates what has been normally accepted as the best posture for sitting for long periods. However, individual preferences must be permitted, and it is therefore important that chairs be well designed and adjustable.

- ▶ In order to achieve satisfactory posture it may be necessary to adjust the work station height. This is the reason that typewriters and computer terminals are often placed on a lower work surface at secretarial work stations.

Seat Posture


Angles of the body at approximately 90°.
Inward curve of spine is supported.
Spine to thigh angle of 90° to 110°.
Thighs should be fully supported on chair.
The front of the seat cushion should be of a "waterfall" design.
Adjust seat so feet are flat on floor and thighs are parallel to floor.

▶ Footrests should be provided where chair or work station height adjustments cannot be made sufficiently to allow the relief of pressure under the thigh from the seat. These should be angled and covered with a nonslip surface to provide comfortable support for the feet.

▶ Headrests should be considered for operators where the head must be tilted forward or backward for prolonged periods. A common application is the use of optical viewing tools such as microscopes. The head is relatively heavy. If the head is not kept straight, the pull of gravity will cause stress and strain in the muscles of the neck.

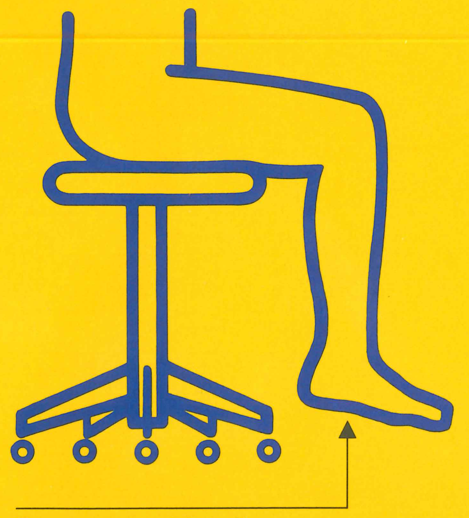
▶ Handrests should be provided for intricate tasks such as fine assembly or inspection. With the weight of the arm supported, the hand is stabilized improving hand dexterity and comfort.

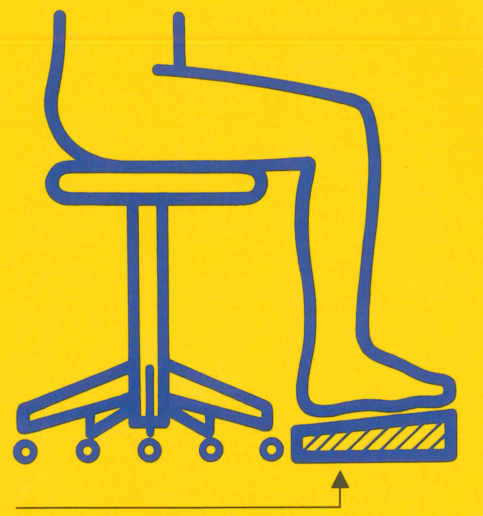
▶ Armrests should be provided when tasks require the arm to be held away from the body. The further the arm is held away from the body, the greater the fatigue and subsequent decrease in manual control. Armrests should be padded and covered with an absorbent nonslip material.

Work stations should be designed to avoid unnatural postures. Operators should not have to lean forward or backward unnecessarily. The use of a device to incline the workpiece freely in any direction (a gimbal) can often help in complicated assembly jobs. Rotary platforms similar to a lazy Susan may also be utilized to access the far side of a workpiece and thereby eliminate bending and extended reaching.

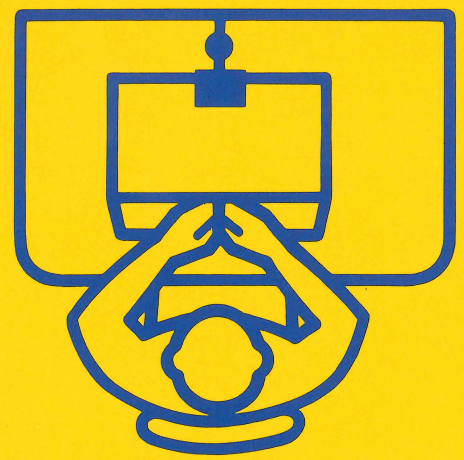
Work stations should be designed in such a way that all objects and tools which require frequent access are located within acceptable reach distances. The design should account for individual variations (anthropometrics).

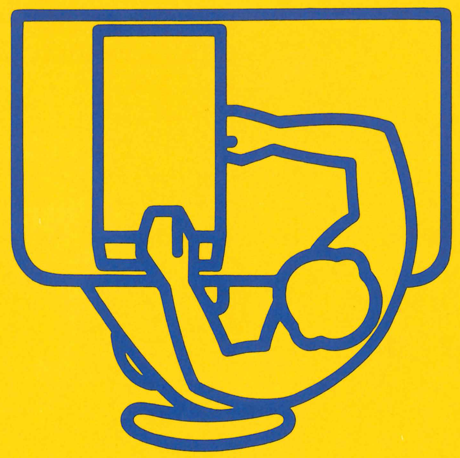
Footrest


Feet not touching floor.
Pressure on thighs causing circulation problems and fatigue.


Feet touching footrest.
No pressure on thighs.

Gimbal


With gimbal, tools or parts are accessible from any angle while maintaining natural posture.


Without gimbal, the body contorts to reach and see, resulting in fatigue.

Anthropometrics

No discussion of posture is complete without reference to anthropometrics.

Human beings come in many shapes and sizes. Anthropometrics is the study of these physical dimensions. Body size varies from one country to another and, with improved nutrition, from one generation to another. Various anthropometric tables exist to assist designers. For example, cars should be designed to have adequate head room and leg room for tall drivers while at the same time providing adequate adjustments in seats, etc., to enable a short driver to reach the controls.

Adult Male

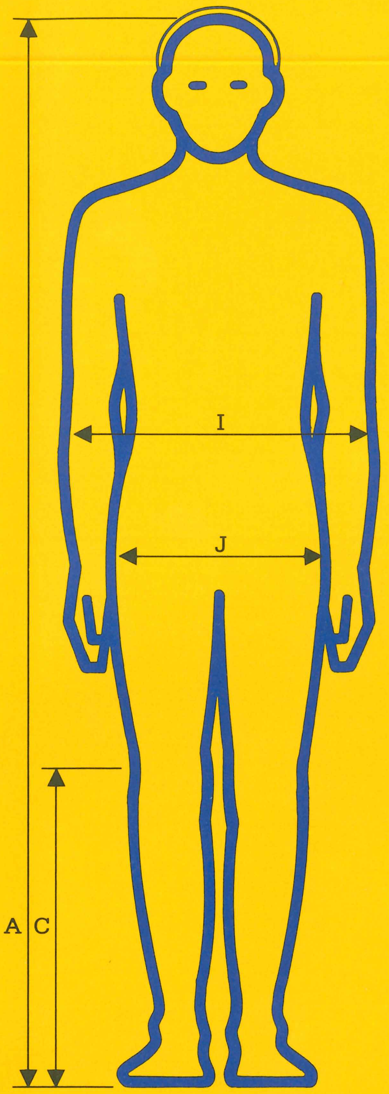
Selected Anthropometrics Features
(NASA Standard 3000, March 1987)

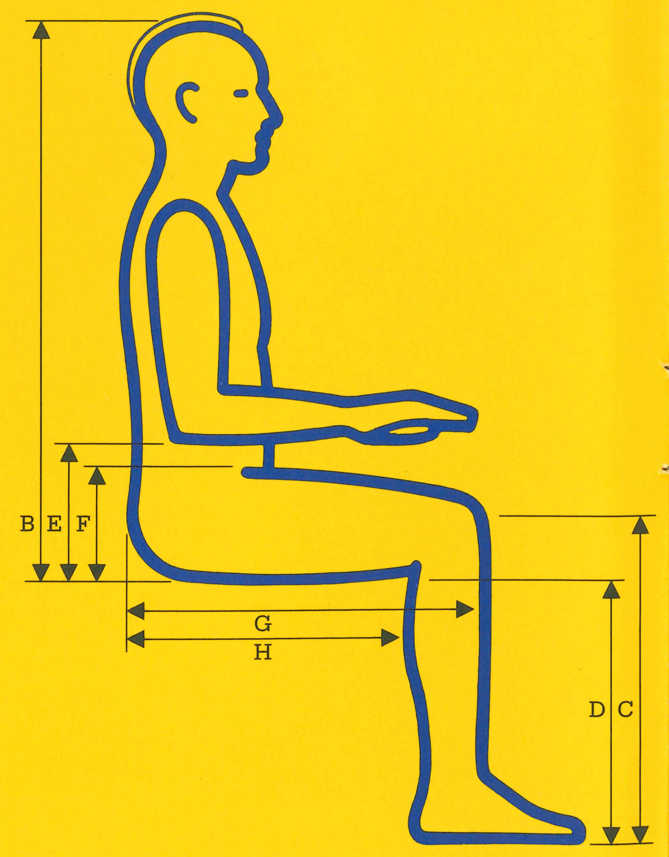
Body Feature	Male, Percentile		
	5th	50th	95th
A Stature (inches)	66.8	70.8	74.8
B Sitting height	35.0	37.1	39.2
C Knee height, sitting	20.7	22.3	24.0
D Popliteal height	16.0	17.5	19.0
E Elbow rest height	8.3	10.0	11.7
F Thigh clearance	5.7	6.6	7.5
G Buttock-knee length	22.4	24.1	25.9
H Buttock-popliteal length	18.5	20.2	21.9
I Forearm to forearm	19.2	21.7	24.2
J Hip breadth	12.9	14.1	15.4
Weight (pounds)	145.1	181.3	217.2

5th percentile: 5% of the population have smaller dimensions.

50th percentile: 50% of the population have larger dimensions and 50% smaller dimensions.

95th percentile: 5% of the population have larger dimensions.





Adult Female

Selected Anthropometrics Features
(NASA Standard 3000, March 1987)

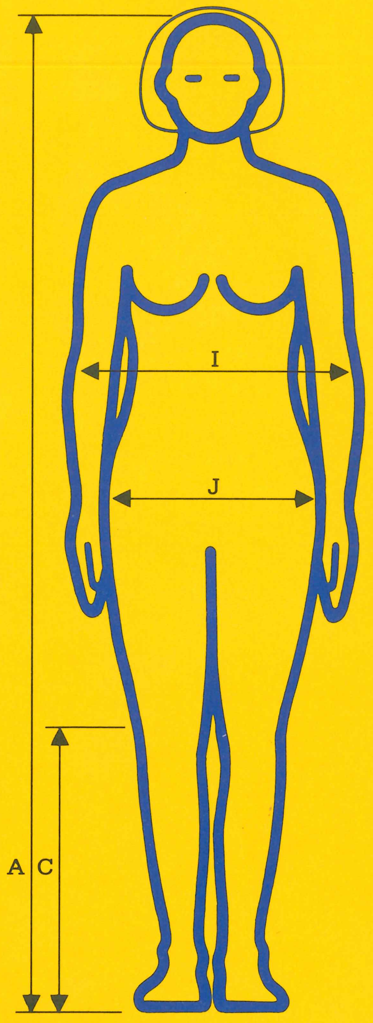
Body Feature	Female, Percentile		
	5th	50th	95th
A Stature (inches)	58.6	61.8	65.0
B Sitting height	30.8	33.4	35.9
C Knee height, sitting	16.4	17.9	19.5
D Popliteal height	13.6	15.1	16.5
E Elbow rest height	8.2	9.9	11.5
F Thigh clearance	4.4	5.1	5.7
G Buttock-knee length	19.2	21.0	22.7
H Buttock-popliteal length	14.9	16.4	17.9
I Forearm to forearm	15.3*	17.2*	19.2*
J Hip breadth	12.0	12.9	13.9
Weight (pounds)	90.4	113.5	136.0

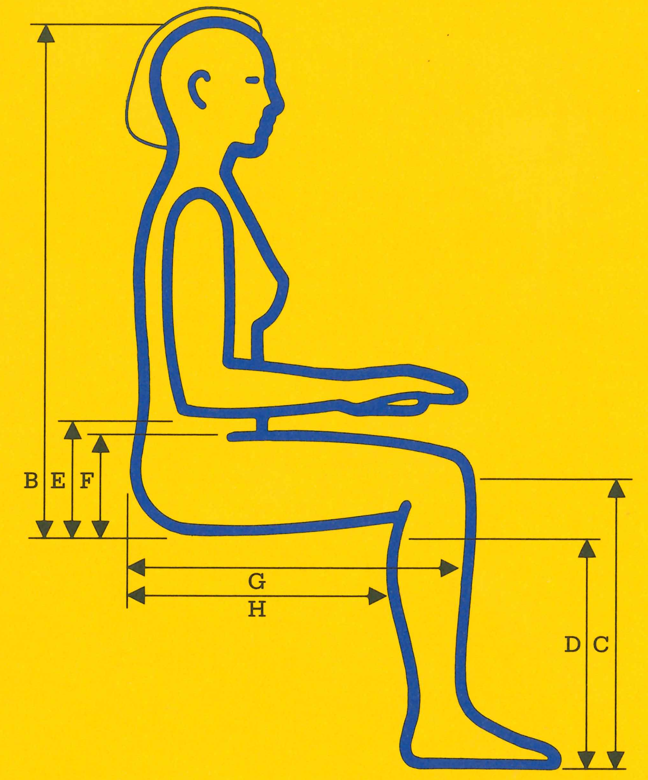
5th percentile: 5% of the population have smaller dimensions.

50th percentile: 50% of the population have larger dimensions and 50% smaller dimensions.

95th percentile: 5% of the population have larger dimensions.

*(interpolated numbers)





The Back

How the Back Works

Try to envision the spine as a column of individual parts held in balance by elastic bands, the muscles and ligaments. Unlike most manmade columns, the human spine is not rigid or straight. The natural curvature is necessary to balance the weight of the torso. Contributing to the curvature are 33 vertebrae, which rest on top of one another separated by the discs. These cushion the bony vertebrae structure from jarring shocks and separate them to give the spine flexibility. Without discs, vertebrae would grind against each other. Discs consist of an outer fibrous encasement with a viscous material inside. They should be firm but resilient when healthy.

The entire back structure is supported by a system of 1,500 muscles, tendons, and ligaments. This structure provides support for the back, helps anchor the limbs, and provides the body with locomotion.

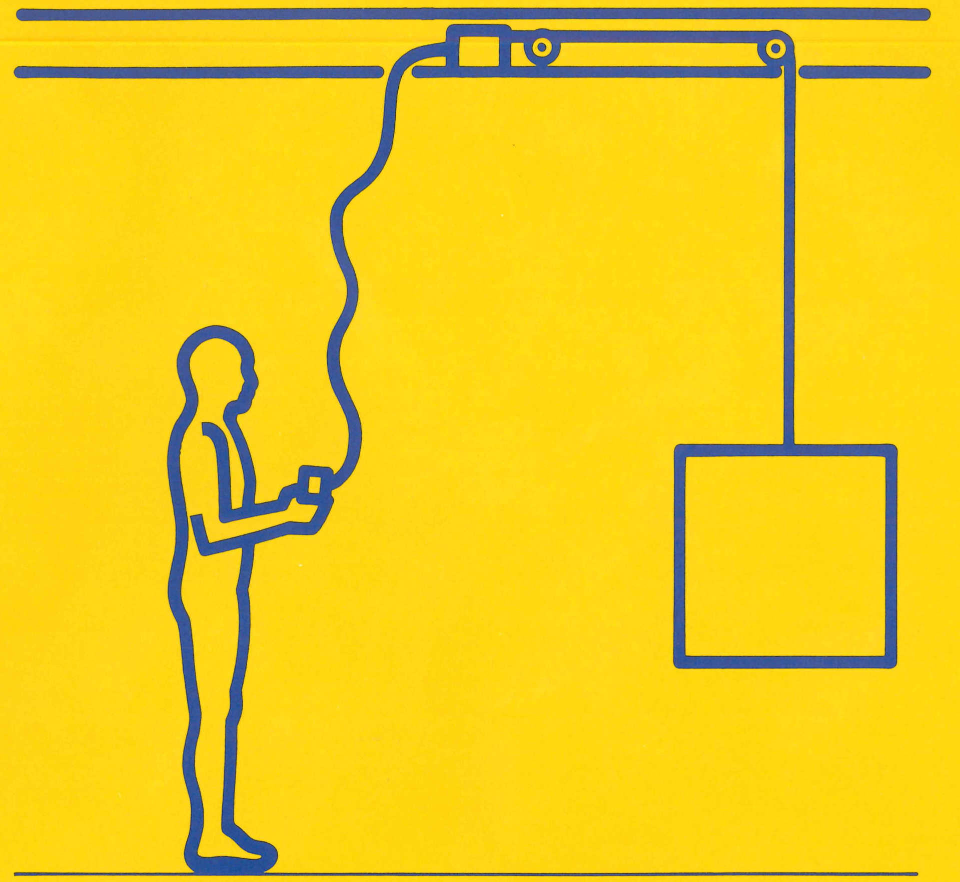
Back Injuries

The majority of the population will have back pain at some point during their lives. This occurs mostly around 40 to 50 years of age. Once a person has had a back injury, they are much more likely to have another injury. The importance of preventing the first injury can't be overemphasized.

One of the most publicized disc problems is erroneously known as the "slipped disc." In reality, it could be a disc that is bulging, ruptured or degenerated, pressing against a nerve which may result in low back pain, or even paralysis. A compressed nerve in the lower back may cause pain radiating into the buttock or legs (sciatica), and may result in leg numbness and muscle spasm.

Lifting with a Crane

The first goal is to design components that can be lifted easily. Where this is not possible, ensure all heavy weights are lifted with mechanical assistance.



Job Design and the Back

The best way to reduce back injuries is to design out the lifting tasks. This statement should be taken seriously and designers should strive to limit the weight of components and packages.

Intelligent job design will reduce problems. For example, when you bend over and twist, the load is much heavier than simply bending over forward. (In the United States the action of bending and twisting is the most common cause of back injuries.) By changing the layout of common lifting tasks, e.g., moving boxes from the end of a roller conveyor onto a pallet, twisting actions can be eliminated at no cost.

When an individual has to stretch and lift at the same time in order to grasp objects at a distance, the weight on the back will increase considerably. Efforts should be made to place the objects to be lifted as near as possible to the body. Minimizing reach and stretch will increase productivity and employee comfort.

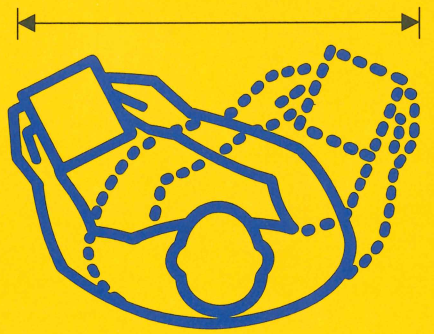
Engineers designing work stations and products should also ensure that attention is given to providing the individual with adequate gripping surfaces or handles. When the job design cannot eliminate excessive stress on the back, lift-assist devices should be considered.

Lifting and Stretching

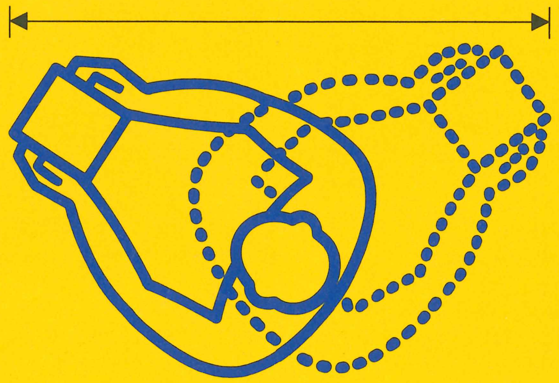
Design storage systems to be within easy reach. Discourage people from lifting heavy weights above shoulder height.

Lifting and Twisting

Good: Torso remains in stable position.



Bad: Torso is twisted from side to side.



Eliminate twisting action from lifting jobs whenever possible—this will reduce injuries.

The Arm and Hand

How the Arm and Hand Work

The arm and hand are designed to perform a range of tasks in many different positions. They are capable of exerting great force as well as fine manual dexterity. Structurally, the arm is best considered in terms of its three major components: shoulder, elbow and hand. Each component has its own characteristics. The shoulder is controlled by muscles in the neck and upper back. The elbow is the least complicated of the components. Together the hand and the wrist have 27 bones. Most of the muscles controlling them are in the forearm.

Ligaments connect the bones to each other and tendons connect muscles to the bones. When a muscle contracts, it pulls the tendon which moves the bone to which it is attached. Portions of these tendons are enclosed in sheaths—shiny and very slippery coverings which protect and lubricate the tendons and permit them to slide back and forth freely. Joints contain bursa, fluid-filled sacks which reduce friction and provide cushioning during motion.

Arm and Hand Injuries

Excessive back and forth movement of a tendon under excess load can cause inflammation (pain, swelling or tenderness) of the tendon or its sheath. Other causes of inflammation in these structures include direct physical trauma, excessive external pressure, and various diseases. When the inflammation involves the tendon primarily, the disorder is known as tendonitis, and when it involves the tendon sheath, it is known as tenosynovitis. When tenosynovitis is associated with the narrowing of the tendon sheath, it can produce trigger finger or de Quervain's disease.

At joints where tendons are unsheathed, such as at the shoulder and elbow, other injuries can occur such as epicondylitis and bursitis with symptoms of pain, tenderness and reduced range of motion. Names you may be familiar with include "pitcher," "golfer" or "tennis" elbow. Pressure on the nerve can produce symptoms of pain, numbness and tingling. These can include problems at the shoulder and carpal tunnel disease, which is compression of the median nerve on the palm side of the wrist.

Regional musculoskeletal illness, cumulative trauma disorder (CTD), and repetitive strain injury (RSI) are terms that have been used to describe repetitive motion problems. Pain can occur from sprains, strains, and acute overuse along with personal medical conditions. Hobbies, participation in sports, activities at home and work tasks can lead to CTDs. Few of those who experience pain in the upper extremities actually suffer from CTD, which usually takes months or even years to develop.

It is important for individuals experiencing persistent pain to have an examination by a qualified medical practitioner to determine the cause of the discomfort, to provide treatment and to help identify activities which may aggravate the condition.

Techniques for Reducing Repetitive Motion Injuries

Cumulative trauma disorders usually develop from a combination of factors including *repetition, duration, position* and *force.* Modification of any one of these elements can often significantly reduce the chances of injury. This can be accomplished through good work practices, training procedures and tool design.

Work Practices

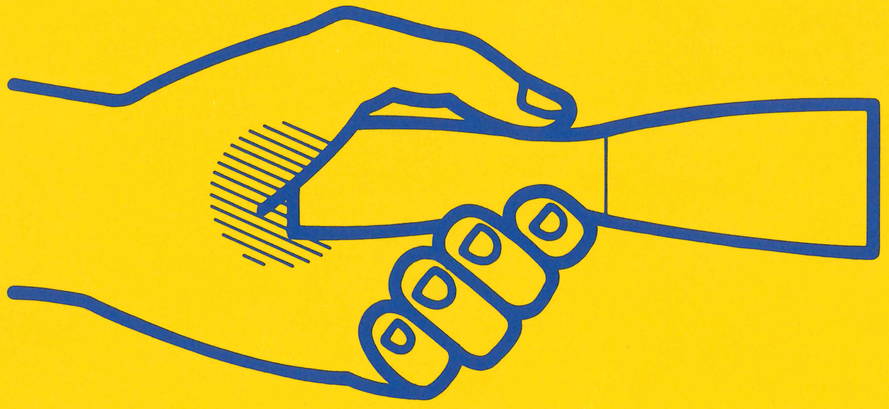
To reduce the time spent performing one specific motion and to allow time for recovery, several employees on a periodic or rotation basis could perform different tasks. In some instances, it may be possible to design a task so that it can be performed with either hand and the employee trained to alternate hands. All tasks should be designed to minimize stress and strain on the arm from the shoulder to the hand.

Bone Structure of the Hand

A very complex multipurpose tool required to perform powerful and repetitive tasks, as well as intricate and delicate motions.

Inflamed Tendon

Avoid hand tools that cause constant compression to the palm of the hand. These tools may cause damage to the tendon sheaths.



Training Procedures

Allowing employees to gradually break into new jobs is a reasonable component of a CTD prevention program. A gradual break-in period allows the hand to adjust to the increased stress of repetitive tasks. Do not require new employees (or newly placed employees) to maintain the same pace as experienced employees.

Employees must be trained in the correct methods of performing their jobs, with particular attention given to correct ergonomics. Trainers must demonstrate tasks that are correct ergonomically to ensure that bad habits are not passed on to trainees. Employees should be encouraged to provide ideas regarding ergonomic changes and improvements.

Hand Tool Design

The design of hand tools influences the positions and motions of the hand. In selecting and designing a hand tool, the following should be considered:

1. Tools and jobs should be designed so that they can be performed with straight wrists. Hands are stronger and less vulnerable to injury when the wrists are kept straight. The illustrations demonstrate commercially available tools that have been designed to reduce bending at the wrist.

2. Avoid narrow tool handles that concentrate large forces onto small areas of the hand. Avoid all sharp edges and corners and use slip-resistant materials for tool handles.

3. Avoid short tool handles that press into the palm of the hand. The palm is very soft and easily damaged. Longer handles which spread pressure over a larger area are recommended. Handles should extend beyond the "fist."

4. Avoid the use of tools with preformed grips that do not fit the individual.

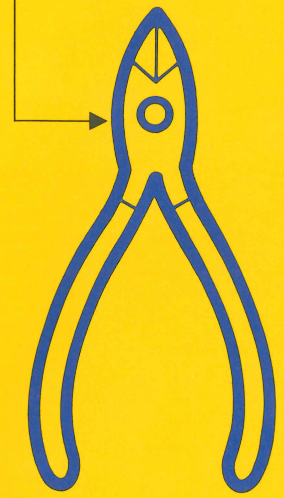
Power Tool Design

1. Use power tools whenever possible. Repeated exertion can cause discomfort. However, power tools, particularly when set to a predetermined torque, often cause a kickback effect. Select tools that minimize the amount of kickback transferred to the hand and wrist. Existing tools can often be modified.

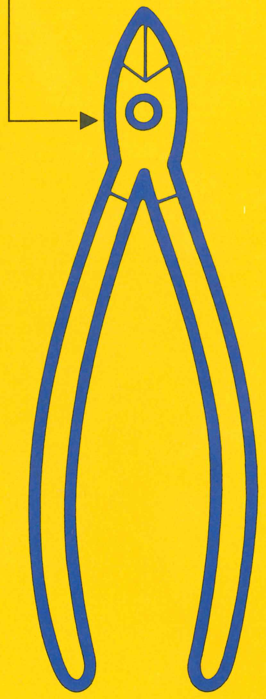
2. Use balanced tools. The center of gravity of the tool should be aligned with the center of the grasping hand so that the hand will not have to overcome rotational moments of torques of the tool.

Hand Tool Design

Avoid short tool handles that press into the palm of the hand. The palm is very soft and easily damaged.



Avoid narrow tool handles that concentrate large forces onto small areas of the hand.



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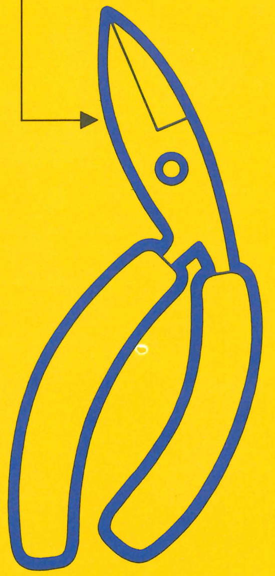
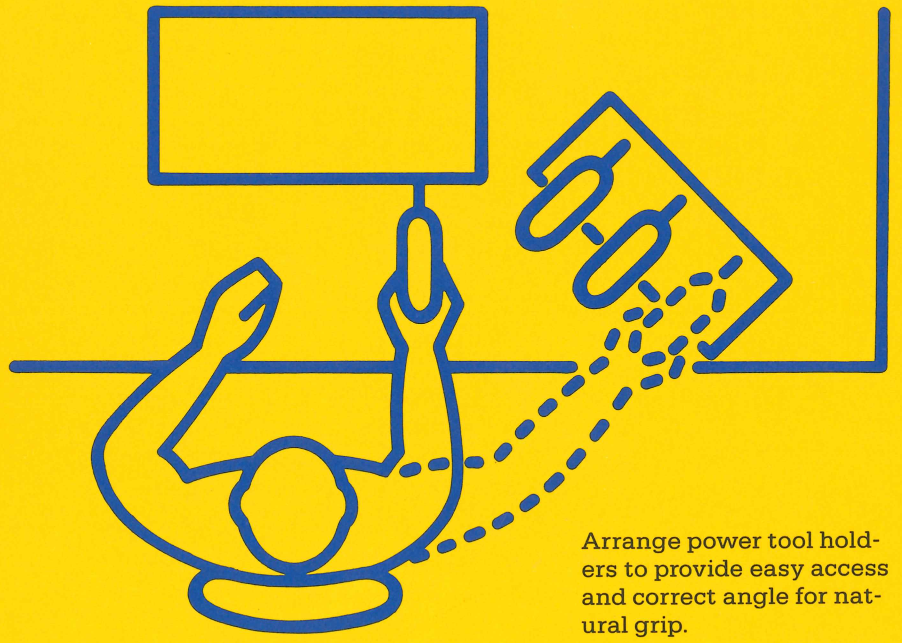


Power Tool Design

When selecting power tools, take noise, weight, and balance into account. Use pistol grip whenever possible.



Arrange power tool holders to provide easy access and correct angle for natural grip.

Environment

The conditions of the surroundings in which a tool or piece of equipment is used to perform a task can have a significant impact on the employee's ability to perform that task. We will consider two such factors—noise and lighting.

Noise can be very distracting and prevent concentrated mental work. In extreme cases, it can also result in physical disorders.

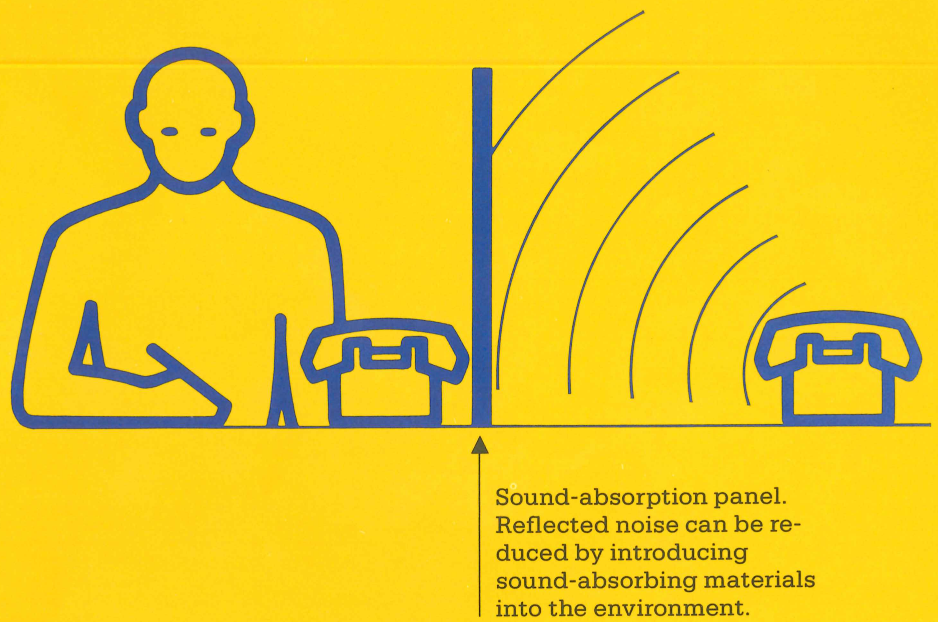
Noise can be characterized in two ways, direct and indirect. A direct noise is determined by the intensity of the source and the distance from the ears. Reflected noise is dependent on the reflection factors of the floor, walls, ceiling, etc., and on the position of these surfaces.

Direct noise should be suppressed by placing covers over impact printers or by isolating sources of noise from the rest of the work area.

A distinction should also be made between meaningful noise and general background noise. Most working environments will have some background noise. However, this noise can become uncomfortable if an irregularity, such as a malfunctioning machine, develops.

Reflected noise can be reduced by introducing sound-absorbing materials into the environment. Often the actual source of noise and/or the technique for controlling it is not readily apparent. In such instances, experts should be consulted.

Noise



Sound-absorption panel. Reflected noise can be reduced by introducing sound-absorbing materials into the environment.

Lighting

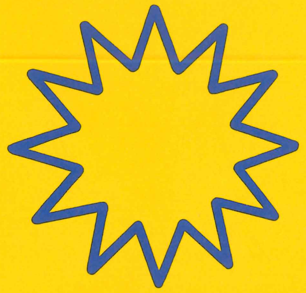
Different tasks require different lighting levels. Intricate assembly tasks require more light than warehouse areas. The table (opposite) shows various tasks and the recommended illumination levels. Energy savings and better quality lighting often result from studies. By putting light where it is needed on the working plane and reducing general light levels, significant improvements can often be made.

Care should be taken to avoid glare. Dials, instrument panels, and VDTs should be positioned carefully in relation to light sources to prevent reflected glare in the glass fronts of the equipment, which makes them difficult to read.

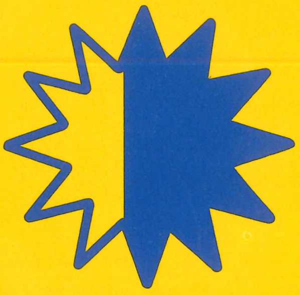
Windows are light sources that can present difficulties. Care should be taken to avoid highly reflective surfaces or naked light in the field of vision.

Visually demanding tasks may occasionally cause employees with uncorrected or wrongly corrected vision some discomfort. VDT operators with bifocal glasses will have to use the lower lens (reading lens) to read the display. In order to do this, the head has to be tilted back. If they continue to do this for extended periods of time, they could suffer from aches and pains in the back and shoulder. To correct this, glasses should be specially prescribed for this job.

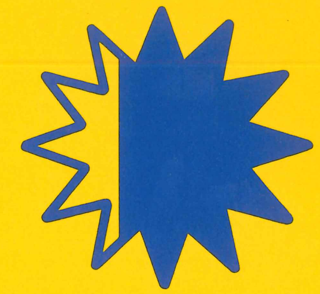
Light Levels



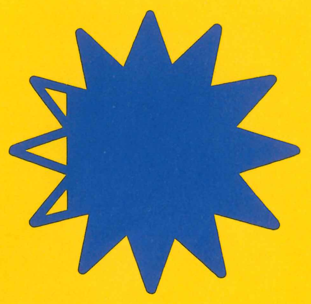
100,000 Lux in bright sunlight.



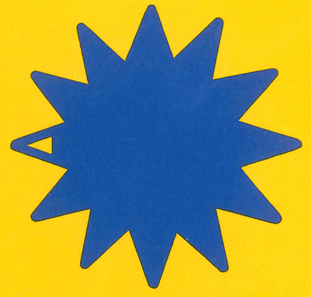
30,000 Lux on overcast day.



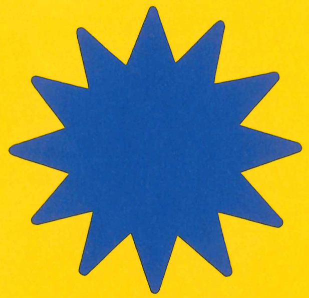
3750 Lux in intricate assembly.



600 Lux in general office areas.



112.5 Lux in warehouse, corridor, stairwell, areas not in constant use.



.10 Lux in full moonlight.

Table of Recommended Illumination Levels

Place or Nature of Work	Recommended Illumination Level in Lux
Offices	
Drawing-offices	1500–750
General offices (clerical work, bookkeeping, typing correspondence, reading, working with office machines)	800–400
Places not in continuous use (Records departments, corridors, waiting rooms, stairways)	150–75
Manufacturing	
Very fine work (Assembling memory cores, transistors, hearing-aids, etc.)	5000*–2500*
Fine Work (Assembly of small parts, setting capstan lathes, precision turning, fine molding, polishing)	2000–1000
General Work (Drilling, rough turning, assembly)	800–400
Coarse Work (Forging, rolling)	300–150

*Possibly general lighting combined with local lighting (See bibliography for illumination references.)

Work Design/Organization

A number of studies conclude that several interacting factors related to a task can contribute to employee health, safety, well-being and productivity. A useful way of looking at a task is as a relationship of three factors: the tool, the work station and environment, and the job content and context. In this handbook we have considered the tool and the work station and its environment.

In any job there is a link between the nature of the job and employee satisfaction. Elements in job content such as challenge, autonomy, feedback, and skill utilization, if not met, will result in lower motivation and satisfaction which may in turn cause perceived health effects. Similarly, elements of job context such as management and support systems, application and software design, work/rest cycles, new technology introduction and training may also have an effect on health and well-being. If the above elements are not considered in the design, the benefits from well-designed tools and work stations may not be realized. As a result many tools and work stations become inappropriately identified as the cause of adverse health effects.

With regard to work/rest cycles, it is not easy to specify precise work/rest cycles for all types of work. The basic physical demands that the tool itself places on the operator may be very modest. On the other hand, mental demands vary widely.

More is known about the relationship between work and rest periods for physical tasks than for mental tasks. The level of difficulty for mental tasks may be significantly influenced by a person's training and skill level. Different people may find the demands for the same mental task to be very different, and of course, motivation makes a great deal of difference.

For some tasks that are neither physically nor mentally demanding, work may be essentially continuous. As the mental and/or physical components of any work significantly increase, some consideration should be given to either a scheduled rest period or a period of work at a task with reduced demands.

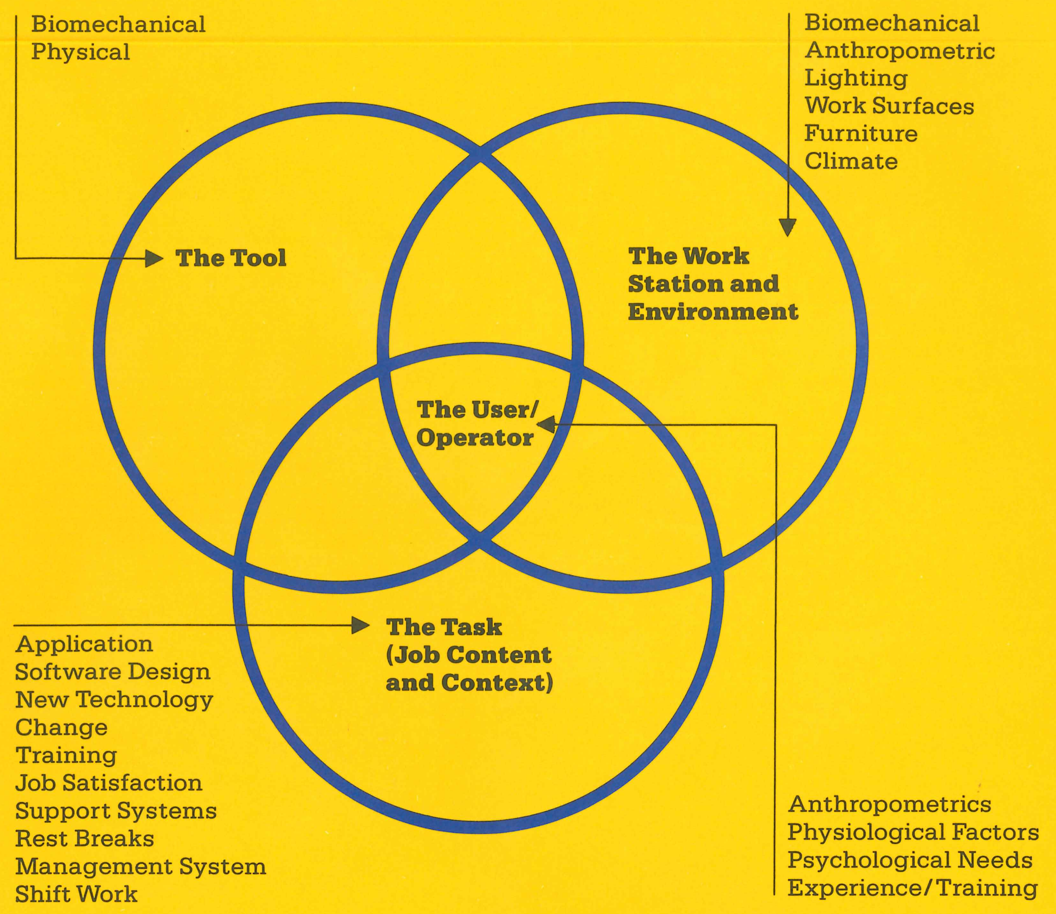
A new job, or a significant change to a person's job, may at first be stressful; more thinking may be required and movements may not be smooth and efficient. As the task is learned, however, and the various required skills are acquired, the overall effort required to perform the task can be reduced. The value of breaks are a function of the task difficulty and the individual employee's requirements.

It is the recovery value of a rest pause that is important, not the duration of the period. The need for breaks depends on the physical and mental demands of the work task, the environment, the work station and the individual operator.

Rather than establish artificial break periods, it is preferable for the manager or supervisor to work with individual employees to determine appropriate breaks. One approach is to design tasks in such a way that periods of concentrated work are spaced throughout the day. During the intervening time, a person would do less demanding work. Giving the individual some discretion over how the work is allocated throughout the day and giving consideration to the individual differences in the need for brief pauses in work can increase feelings of personal control and autonomy.

Tools and work stations are designed to enhance the individual's performance and job satisfaction. They should not be used as a vehicle to inhibit or control. The design of automated or computerized work systems must account for both the physiological and psychological needs of people.

Job Factors



Visual Display Terminals

Let us now illustrate some of the preceding recommendations with an example. The use of visual display terminals (VDTs) is becoming widespread, and for many people VDTs represent relatively new and unfamiliar additions to the work environment.

The work at visual displays is similar to that of typewriters. It may require sitting still for a considerable amount of time with small frequent movements of the eyes, head, arms and fingers. Retaining this fixed posture over a long period of time requires significant static holding force and causes fatigue.

Therefore, it is important to have a well-designed chair that allows the body to shift position to the greatest extent possible and gives the greatest support, especially for the back.

It is important that the operator be aware of correct working posture.

To allow for differences in height and body build, it is desirable to provide adjustable desks or terminal bases where practical.

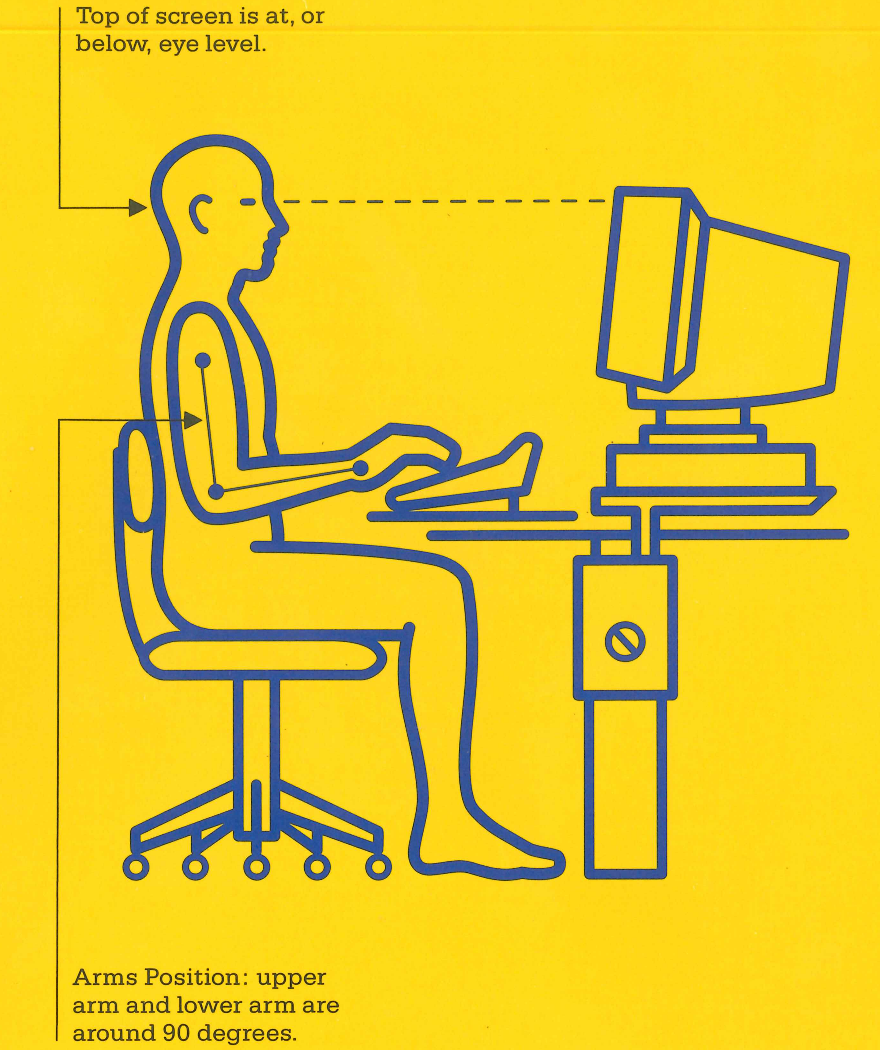
Adjustable Terminal Base

An adjustable terminal base should include the following features:

- ▶ Height-adjustable VDT platform
- ▶ Height-adjustable sliding keyboard platform
- ▶ Optional tilt or swivel VDT platform

Comfortable keyboard height depends on arm position. If the operator is seated correctly, the upper arm should be nearly vertical and the lower arm nearly horizontal. The hands may be tilted up slightly to allow the fingers to travel freely over the core of the keyboard without gross arm movements.

Keyboard/Platform Height



Top of screen is at, or below, eye level.

Arms Position: upper arm and lower arm are around 90 degrees.

Most of the tasks associated with visual displays do not require fine detail work and diffuse (indirect) lighting is appropriate.

The advantages of diffuse lighting are twofold: there tend to be fewer hot spots, or glare surfaces, in the visual field, and the contrasts created by the shape of objects tend to be "softer." The result, in terms of luminous intensities, is a more uniform visual field.

Care also should be taken to ensure that work station surfaces are antiglare (i.e., matte finish).

There has been much discussion about providing low ambient (room) lighting with individual work station lighting in addition, particularly for terminal rooms. While individual flexibility is almost always advantageous, the goal is to reduce the glare caused by non-diffused light reflecting off the screen surface or in the field of view. Where used, work station lighting should be easily adjustable and directed at source documents and not the screen surface.

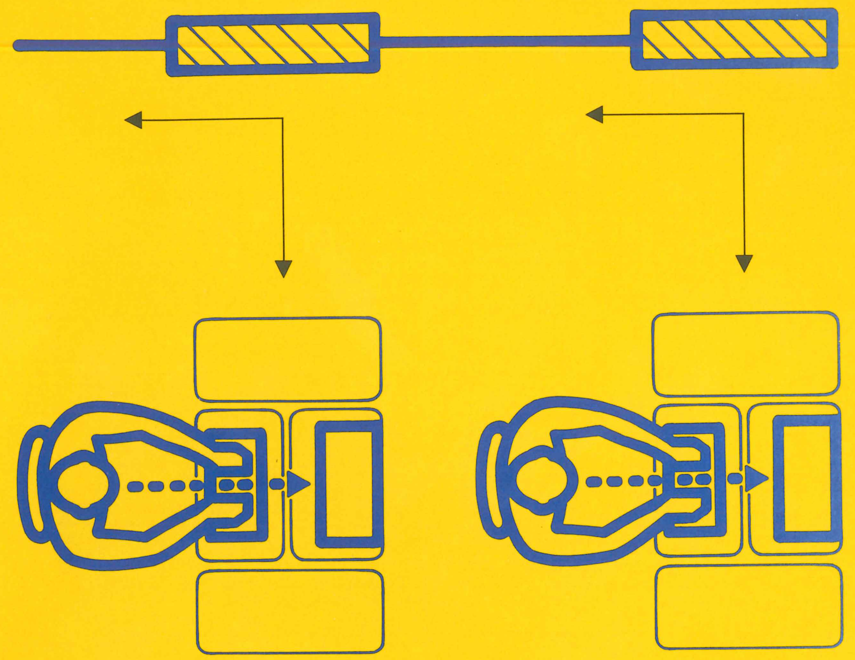
Where indirect lighting is not used, parabolic louvers on overhead lights are probably the next best way to ensure that light is diffused.

Avoid placing terminals in such a way that glare is reflected by the screen into the user's eyes. The face of the screen should be at right angles to windows and light sources.

For this reason, VDTs should usually be installed at 90 degrees to windows. Care should be taken, particularly when terminals are installed within 20 feet of windows, to ensure that there is some method of blocking the sun's light, such as blinds or curtains.

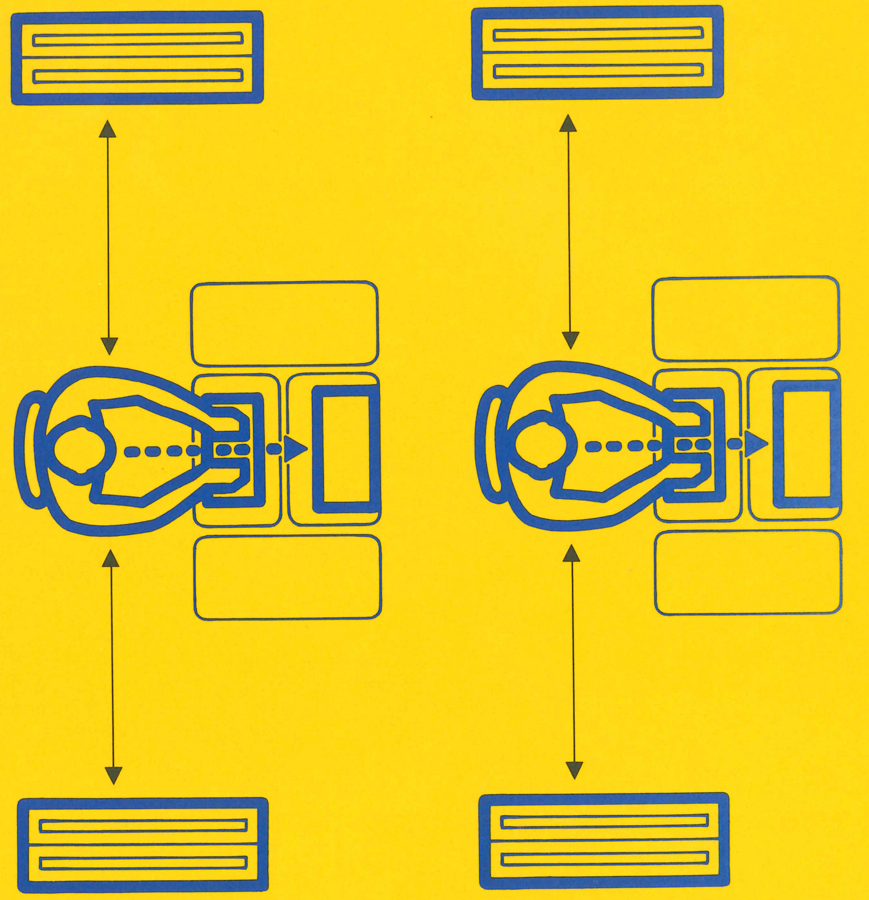
Windows

To avoid glare and reflections, position terminal screens at right angle to windows.



Overhead Lighting

To avoid glare and reflections, do not position terminal screens directly under overhead lights.



Good Management Practice For VDT Applications

The following are some recommendations, most of which equally would apply to other office work:

▶ Keep cables tidy and out of the way.

▶ Do not consider the user or the terminal in isolation from the surrounding environment.

▶ Operators can be helpful in proposals for office changes. People are adaptable, but only within limits.

▶ VDTs do produce a small amount of heat. Where several are installed, additional attention to ventilation may be required.

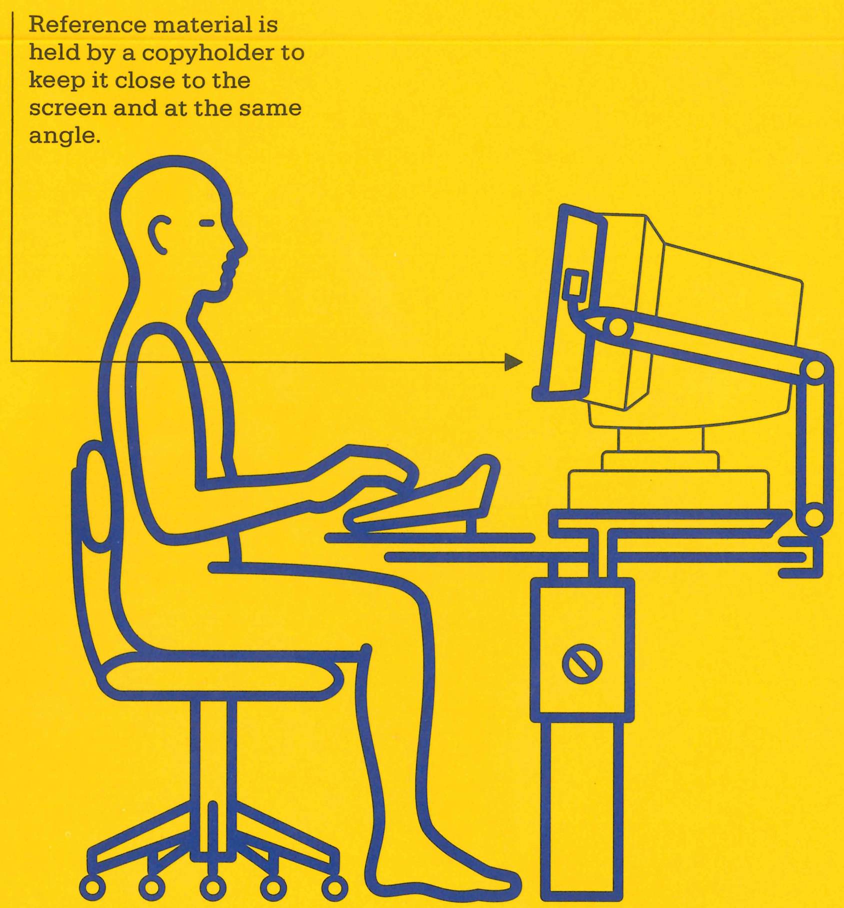
▶ Terminals consume some desktop space. Sufficient room should be provided for all the job aids and documents.

▶ For tasks involving frequent scanning between screen and source material, a document holder alongside the screen is often advantageous.

▶ Text entry ("regular" typing) requires equal use of both hands for keying, so the keyboard should be directly in front of the operator at a comfortable height.

▶ Data entry, however, usually requires one hand for keying, the other for such activity as maintaining a source document reference position or manipulating source documents. For data entry, therefore, it is best to place the keyboard directly in front of the keying hand, and to leave a large area free for the activity of the other hand.

Copyholder



Reference material is held by a copyholder to keep it close to the screen and at the same angle.

Looking Ahead

The complexity of the interrelationships between people and machines will continue to grow. The need for the application of the principles of ergonomics to the design of tools, equipment and the work place will become even more imperative. This requires management commitment, employee involvement and professional advice and counsel.

This handbook provides a general understanding of the important emerging field of ergonomics. For further information, a bibliography is included.

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